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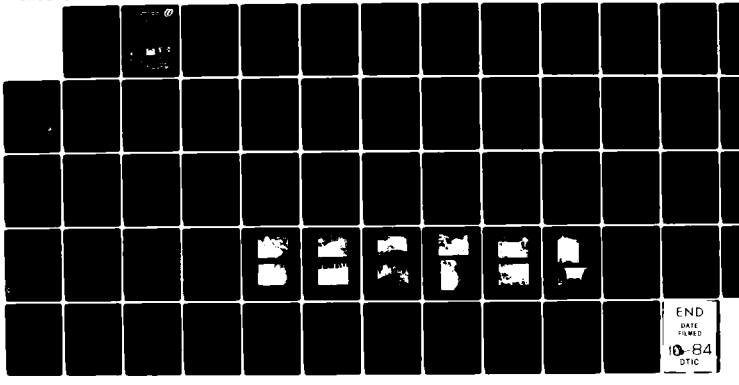

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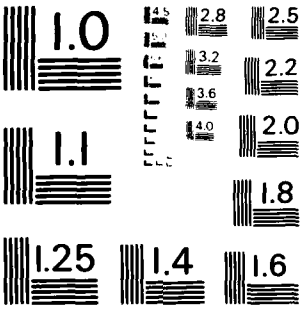

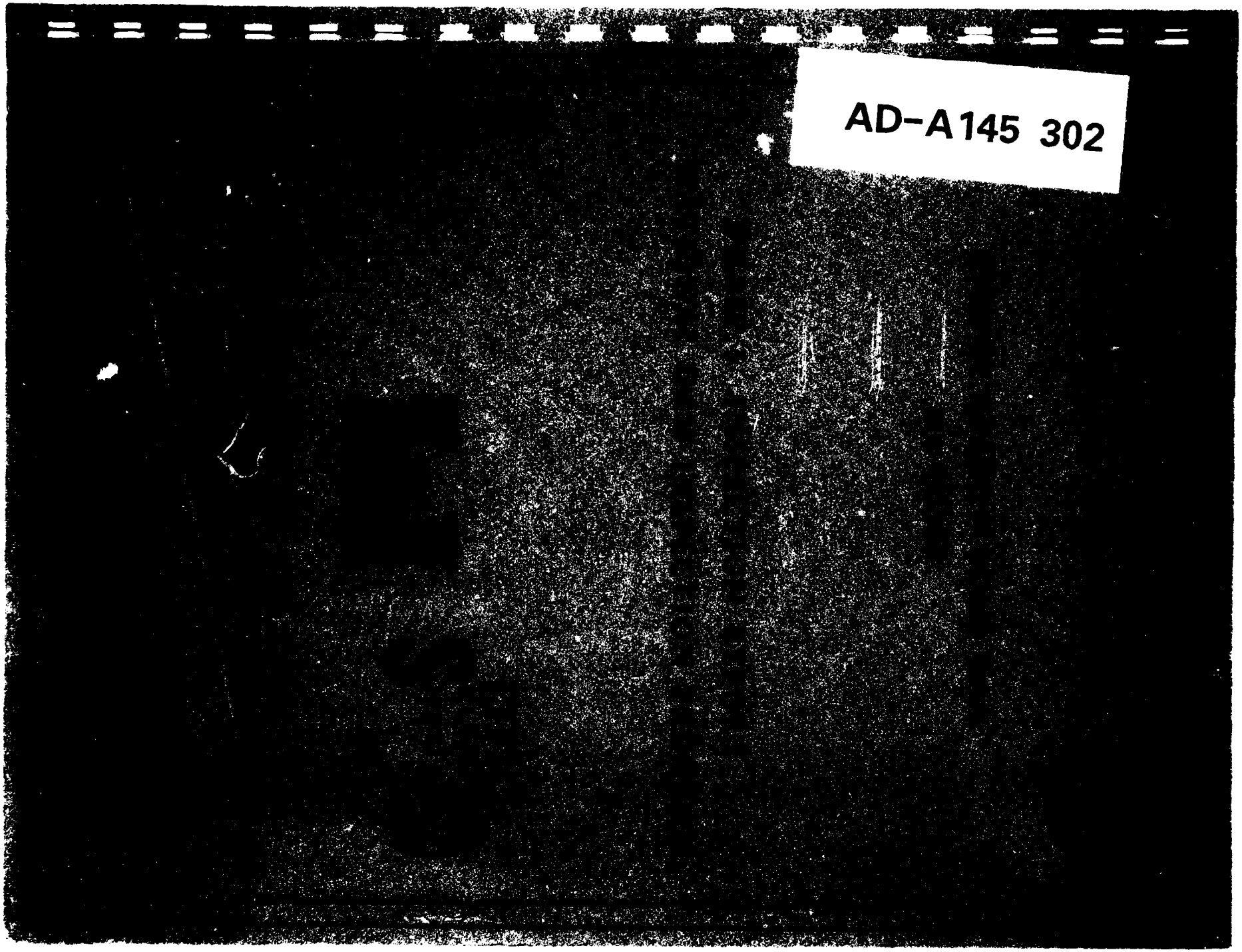

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18. SUPPLEMENTARY NOTES

Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,
Merrimack River Basin
Ashburnham, Massachusetts

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Stodge Meadow Pond Dam is formed by an approximately 250 ft. long earth embankment which has a maximum height of 15 ft. Stodge Meadow Pond Dam was formerly classified as having a "high" hazard potential in the Corps of Engineers National Inventory of Dam. The Dam has been reclassified as having a "low" hazard potential in the event it were to fail. Based on the size (small) and hazard potential (low) classifications, the test flood for this dam is ¼ the PMF.

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF

NEDED

APR 17 1979

Honorable Edward J. King
Governor of the Commonwealth of
Massachusetts
State House
Boston, Massachusetts 02133

Dear Governor King:

I am forwarding to you a copy of the Stodge Meadow Pond Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Department of Environmental Quality Engineering, the cooperating agency for the Commonwealth of Massachusetts. In addition, a copy of the report has also been furnished the owner, Stodge Meadow Association, Inc., Stodge Meadow, Ashburnham, Massachusetts 01430.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Department of Environmental Quality Engineering for your cooperation in carrying out this program.

Sincerely yours,

JOHN P. CHANDLER
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

MERRIMACK RIVER BASIN
ASHBURNHAM, MASSACHUSETTS

STODGE MEADOW POND DAM

MA 00009

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS 02154

FEBRUARY 1979

PHASE I INVESTIGATION REPORT
NATIONAL DAM INSPECTION PROGRAM

Identification No.:	MA 00009
Name of Dam:	Stodge Meadow Pond
Town:	Ashburnham
County:	Worcester
State:	Massachusetts
Stream:	Tributary to South Brook
Date of Site Visit:	15 November 1978

BRIEF ASSESSMENT

Stodge Meadow Pond Dam is formed by an approximately 250 ft. long earth embankment which has a maximum height of 15 ft. A conduit spillway controlled by an overflow weir with stoplogs and a gated outlet conduit are both appurtenant to the dam. The dam is over 100 years old, except for the conduit spillway, which was constructed in 1977. The pond has a maximum storage capacity of about 900 acre-ft. and is used for recreational purposes by the surrounding group of property owners, who collectively own the pond and dam.

Stodge Meadow Pond Dam was formerly classified as having a "high" hazard potential in the Corps of Engineers National Inventory of Dams. Due to the lack of downstream development, however, the Dam has been reclassified as having a "low" hazard potential in the event it were to fail.

The dam is in good condition, based on a visual examination of the structure. Although some deficiencies were noted, there was no evidence of settlement, lateral movement or other signs of structural failure or other conditions which would warrant urgent remedial action.

Based on the size (small) and hazard potential (low) classifications in accordance with discussions with Corps of Engineers personnel, the test flood for this dam is one-fourth the Probable Maximum Flood (1/4 PMF). With the water level at the top of the dam, the ungated spillway capacity is 325 cfs. Hydraulic analyses indicate that the test flood outflow of 240 cfs (inflow 605 cfs or 2,600 csm) can be passed with a freeboard of 0.4 ft. and an unused surcharge-storage of 210 acre-ft. remaining.

Stodge Meadow Association, Inc., owner of the dam, should implement several remedial measures, including monitoring an apparent seepage area, repairing and extending the upstream slope protection and cutting off trees and brush on the embankment as outlined in Section 7.3, within two years after receipt of this report. As also recommended, a program of biennial periodic technical inspections should be instituted.

HALEY & ALDRICH, INC.
by:

Peter L. LeCount
Vice President

This Phase I Inspection Report on Stodge Meadow Pond Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

Joseph A. McElroy

JOSEPH A. MCELROY, MEMBER
Foundation & Materials Branch
Engineering Division

Carney M. Terzian

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

Joseph W. Finegan, Jr.

JOSEPH W. FINEGAN, JR., CHAIRMAN
Chief, Reservoir Control Center
Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:

Joe B. Fryar

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, DC 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I Investigations are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the test flood is based on the estimated "probable maximum flood" for the region (greatest reasonably possible storm run-off), or a fraction thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

The Phase I Investigation does <u>not</u> include an assessment

of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespass and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

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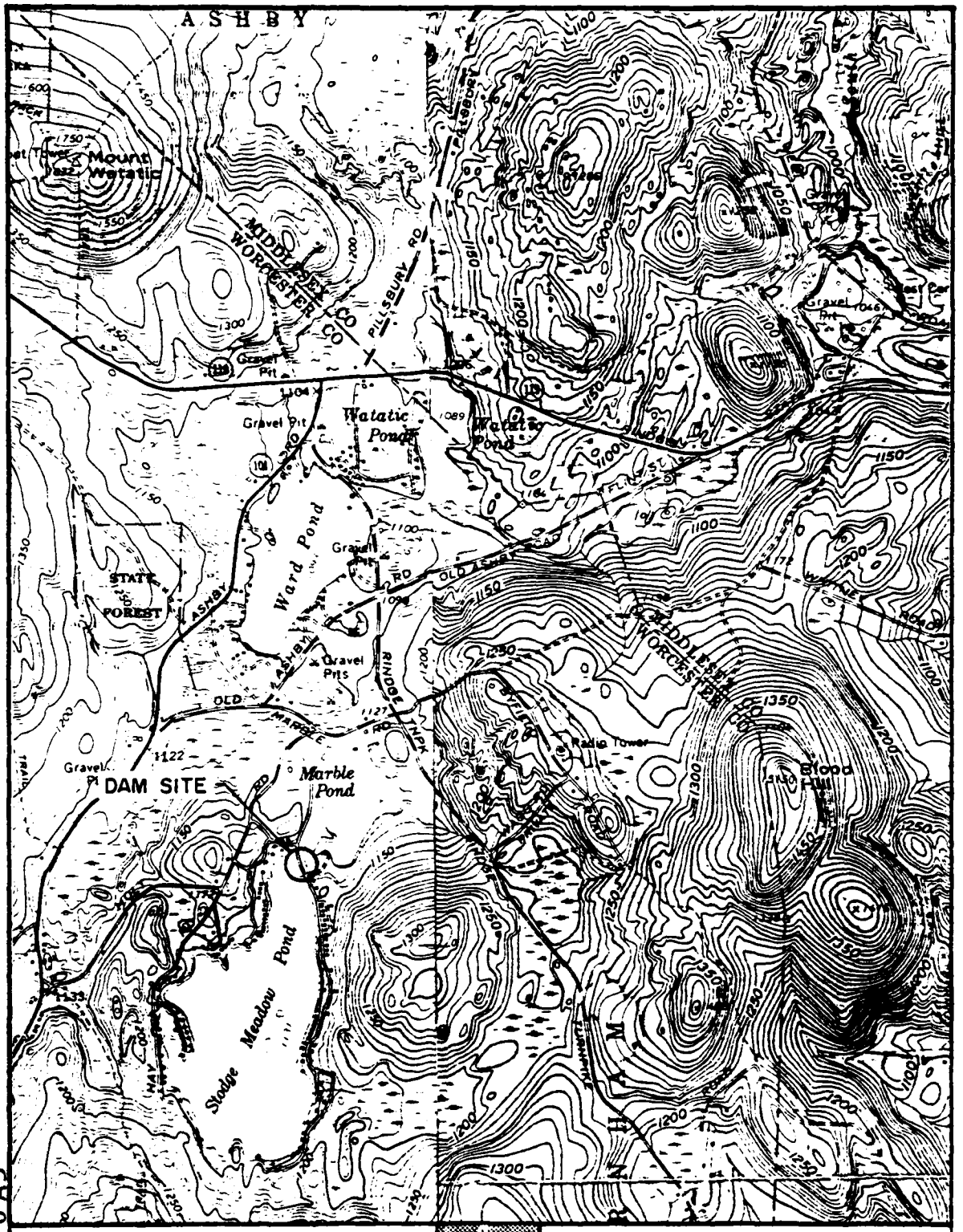
1. Overview of Stodge Meadow Pond Dam showing upstream side



FILE NO. 4270 A5

DAM: Stodge Meadow Pond

IDENTIFICATION NO. MA 00009

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LOCATION MAP
USGS QUADRANGLE
ASHBURNHAM, MA
APPROX. SCALE: 1"= 2000'

PHASE I INVESTIGATION REPORT
NATIONAL DAM INSPECTION PROGRAM
STODGE MEADOW POND DAM
MA 00009

SECTION 1 - PROJECT INFORMATION

1.1 General

a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region.

Haley & Aldrich, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Massachusetts. Authorization and notice to proceed were issued to Haley & Aldrich, Inc. under a letter dated 28 November 1978 from Colonel Max B. Scheider, Corps of Engineers. Contract No. DACW33-79-C-0018 has been assigned by the Corps of Engineers for this work. Camp, Dresser & McKee, Inc. was retained as consultant to Haley & Aldrich, Inc. on the structural, mechanical/electrical and hydraulic/ hydrologic aspects of the Investigation.

b. Purpose of Inspection. The primary purposes of the National Dam Inspection Program are to:

1. Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

2. Encourage and prepare the states to initiate quickly effective dam safety programs for non-Federal dams.

3. To update, verify and complete the National Inventory of Dams.

1.2 Description of Project

a. Location. The dam is located at the northeast corner of Stodge Meadow Pond as shown on the Location Map, page vii. The center of Ashburnham, Massachusetts is approximately 2.5 miles southwest of the dam site. Flow from the dam is generally northeasterly to South Brook and into New Hampshire before joining the Souhegan River five miles from the dam.

b. Description of Dam and Appurtenances. Stodge Meadow Pond dam consists of an earth embankment approximately 250 ft. in length with a conduit spillway controlled by stoplogs near the left abutment and a gated outlet structure near the right abutment. The general configuration of the dam and appurtenances is shown in the Site Plan Sketch, page C-1. Details of the spillway and outlet are shown in drawings included on pages B-3 and B-4.

The embankment is approximately 25 ft. wide at the crest, except for a filled area 40 ft. wide on either side of the spillway. The upstream slope generally has some type of stone protection starting 2 ft. below the crest. A vertical stone wall retains a 150-ft. length of embankment on the downstream side. A 20-ft. wide unpaved road runs the length of the embankment crest.

The conduit spillway on the left side is controlled by a concrete overflow weir which has a 27-ft. perimeter, irregularly shaped crest at El. 1132. A 2-ft. long section of the crest can be lowered up to 3.5 ft. by removing stoplogs. Discharge is through two uncontrolled 54-in. diameter corrugated steel pipes to the downstream channel.

The gated outlet conduit on the right side of the dam has an apparent intake weir at El. 1133.6 which is covered by a steel grating. However, flow is normally through open joints in the vertical cut stone structure wall to a horizontal closed discharge conduit (assumed 24-in. diameter) with invert at approximately El. 1119. A locked cut stone gate house near the top of the downstream slope protects the control to the gate valve. The opening at the discharge end is 1.8 ft. high by 2.6 ft. wide.

c. Size Classification. The storage to the top of the dam is estimated to be 900 acre-ft., and the height of the dam is approximately 15 ft. Storage of less than 1000 acre-ft. and a height of less than 40 ft. classifies the dam in the "small" category according to the guidelines established by the Corps of Engineers.

d. Hazard Classification. The dam is currently classified as having a "high" potential in the Corps of Engineers National Inventory of Dams. Based on the Phase I Investigation including a dam failure analysis, Appendix D, it is recommended that this classification be changed to "low" hazard category. If the dam were to fail no loss of life is expected from the flood flows and the property damages would be small as described under Section 5.1.f

e. Ownership. The dam and water rights are currently owned by a group of approximately 100 property owners who have incorporated as the:

Stodge Meadow Association, Inc.
Stodge Meadow
Ashburnham, MA 01430

The earliest available records indicate that the dam was owned in 1924 by Columbia Manufacturing Co., Greenville, N.H. The dam may subsequently have been owned by Denim Mills, Inc. or Greenville Mills, Inc., both of Greenville, N.H., in the late 1930's. In any case, Souhegan Real Estate Co., 234 Congress Street, Boston, MA, was the owner from the early 1940's through 1969, when the current owners were incorporated.

f. Operator. Mr. Raymond L. Leslie, President of the Stodge Meadow Association, Inc., has been responsible for operation, maintenance and safety of the dam since 1969. His phone number is (617) 827-5595.

g. Purpose of Dam. The level of Stodge Meadow Pond is regulated by the dam for recreational purposes.

h. Design and Construction History. No original design and construction records are available for this dam. The current owners report that the dam was built in 1863 to provide a water source for use by mills. It is believed that no significant modifications were made to the dam until 1977. Until that time the left spillway was extremely small, as shown in the drawing on page B-3.

In spring of 1977, a new conduit spillway structure was built by Honkala Construction Co., Ashby, MA, according to design criteria, plans and specifications prepared by George J. Lanides, P.E., page B-4.

i. Normal Operational Procedures. The pond level is controlled by the insertion and removal of stoplogs at the conduit

spillway control structure. The operator reportedly attempts to maintain the pond near El. 1132 (crest of concrete weir) with all 3.5 ft. of stoplogs in place from spring through summer. In fall, 2 ft. of stoplogs are removed to drop the level of the pond during winter. The outlet conduit gate valve has been normally closed since the 1977 spillway construction.

1.3 Pertinent Data

All elevations reported herein are based on those reported on the drawing "Site Plan of Dam Area" prepared by Michael S. Szoc, 12 March 1974. The datum used is Mean Sea Level (MSL).

a. Drainage Area. The Stodge Meadow Pond Dam is located in the Town of Ashburnham. The watershed above the dam is 597 acres (0.93 sq. mi.). The majority of the drainage area consists of wooded rolling hills with approximately 20 percent of the total area being surface water and 6 percent being meadows.

b. Discharge at Dam Site

1.	Outlet works.....	Assumed 24-in. dia. pipe at invert El. 1119.1 (intake is dry masonry wall on pond side, where bottom is El. 1124.35)
2.	Maximum known flood at dam site.....	Unknown
3.	Ungated spillway capacity at top of dam.....	325 cfs at El. 1134
4.	Ungated spillway capacity at test flood pool elevation.....	240 cfs at El. 1133.6
5.	Gated spillway capacity at normal pool elevation.....	Not applicable
6.	Gated spillway capacity at test flood pool elevation.....	Not applicable
7.	Total spillway capacity at test flood pool elevation.....	240 cfs at El. 1133.6
8.	Total project discharge at test flood pool elevation.....	245 cfs at El. 1133.6

c. Elevation (ft. above MSL)

1.	Streambed at centerline of dam	1126.0
2.	Maximum tailwater	Unknown
3.	Upstream portal invert diversion tunnel	Not applicable
4.	Recreation pool	1131
5.	Full flood control pool	Not applicable
6.	Spillway crest (without stoplogs)	1128.5
	(with stoplogs)	1132.0
7.	Design surcharge - original design	Unknown
8.	Top of dam	1134.0 min.
9.	Test flood design surcharge	1133.6

d. Reservoir

1.	Length of maximum pool	0.85 mi. (Est.)
2.	Length of recreation pool	0.80 mi. (Est.)
3.	Length of flood control pool	Not applicable

e. Storage (acre-feet)

1.	Recreation pool	580
2.	Flood control pool	Not applicable
3.	Spillway crest	690
4.	Top of dam	900
5.	Test flood pool	860

f. Reservoir Surface (acres)

1.	Recreation pool	120
2.	Flood control pool	Not applicable
3.	Spillway crest	125
4.	Test flood pool	132
5.	Top of dam	135

g. Dam

1.	Type	Earthfill
2.	Length	250 ft.
3.	Height	15 ft.
4.	Top width	Varies (approx. 25 ft.)

5.	Side slopes.....	Earth slopes approx. 2 to 3H on 1V, partial vertical walls (downstream and upstream)
6.	Zoning.....	Unknown
7.	Impervious core.....	Unknown
8.	Cutoff.....	Unknown
9.	Grout curtain.....	Unknown

h. Diversion and Regulating Tunnel. Not applicable

i. Spillway

1.	Type.....	Overflow, concrete gravity type, with two 4.5-ft. dia. conduits. Flow is partially controlled by stoplogs across a 2-ft. wide section
2.	Length of weir.....	27 ft.
3.	Crest elevation.....	1128.5 at stoplogged section, 1132.0 along rest of weir
4.	Gates.....	None (stoplogs are a maximum of 3.5 ft. in height)
5.	U/S channel.....	Not observed
6.	D/S channel.....	Hand placed and grouted granite blocks for a section about 14-ft. wide and about 30-ft. long
7.	General.....	The new spillway was constructed in 1977. Its overflow capacity is about 50 percent of the downstream conduit capacity

j. Regulating Outlets. The existing 24-in. dia (assumed) outlet is located about 190 ft. right (south) of the spillway. The outlet structure entrance is a dry stone masonry riser which allows pond water to infiltrate into the outlet pipe. The available drawings indicate that the bottom elevation of the pond upstream of the intake is 1124.35 and the pipe invert elevation is 1119.2. Flow through the pipe is controlled by a gate valve which is normally closed and under full hydraulic head. It was reported by the owner

that at a normal pond level of El. 1131 to 1132, the water surface elevation in the pond would drop one inch if the gate valve is maintained fully open for a period of 24 hours.

SECTION 2 - ENGINEERING DATA

2.1 Design Data

No design data for the original dam were located and none are believed to exist.

Two drawings were prepared by a registered land surveyor in 1974. One shows the site plan of the dam area and the other shows the two outlets existing at that time.

A drawing showing the plans, specifications and design criteria for the spillway construction in 1977 was prepared by a professional engineer in October 1976.

2.2 Construction Data

No records of the original construction or the 1977 spillway construction were located and none are believed to exist.

2.3 Operation Data

There is no data on the operation of the dam other than the conditions reported in prior inspection reports dating back to 1924.

2.4 Evaluation of Data

a. Availability. A detailed list of all engineering data available for use in preparing this report can be found on page B-1. Selected documents from the listing are also included in Appendix B.

b. Adequacy. A review of design and construction data is a highly desirable factor in developing a thorough Phase I assessment. However, there were insufficient engineering data available for this dam to allow for such an assessment. Therefore, this evaluation of the dam is based primarily on visual inspection, past performance and engineering judgement.

c. Validity. The information contained in the engineering data may generally be considered valid. However, details on the drawings are shown as designed and may vary slightly from those actually built. For example, the stoplogs are located on the right side of the spillway weir, not on the left as shown on the drawing, and the spillway conduits are corrugated metal pipe rather than concrete.

SECTION 3 - VISUAL EXAMINATION

3.1 Findings

a. General. The Phase I visual examination of the Stodge Meadow Pond dam was conducted on 15 November 1978.

In general, the project was found to be in good condition. Several deficiencies which require correction were noted.

A visual inspection check list is included in Appendix A and selected photographs of the project are given in Appendix C. A Site Plan Sketch, page C-1, shows the direction of view of each photograph.

b. Dam. The upstream side, Photos No. 1, 2 and 3, is covered by brush, saplings and scattered trees up to 24-in. diameter. The slope is gentle, about 2 to 3H on 1V. Stone shoreline protection generally starts approximately two feet below the top of embankment.

Along the shoreline adjacent to the outlet structure intake, Photo No. 2, stones from about 100 pounds to nearly one (1) cubic yard in size form a stone wall. Several stones are dislodged and local erosion has occurred a maximum of 8 ft. back from the wall. This wall structure deteriorates to random large stones about 50 ft. left of the intake structure. The shoreline protection from that point to the conduit spillway, Photo No. 3, consists of a locally thin layer of cobbles and boulders which extend out at least 10 ft. beyond the shoreline. The root mat of the trees is undercut above the water level.

The downstream side is retained in part by a vertical cut stone masonry wall a maximum of approximately 8 to 9 ft. in height, Photos No. 4 and 5. The stones are up to 3 ft. by 4 ft. in size and generally intact. Trees up to 24-in. diameter are present above and below the wall. The surficial earth below the wall is of an organic nature, soft, and was covered by leaves. Pockets of ponded surface water in a 15-ft. long area at the toe in the area of maximum dam height, near Photo No. 5, indicate possible seepage. However, no flowing water was observed.

The top of the embankment is a relatively level, gravel surfaced roadway, Photo No. 6. The crest is generally from 20 to 25 ft. wide except in the area adjacent to the right spillway where it is 40 ft. wide, Photo No. 7. The water

level was approximately 3.2 ft. below the low point of the top of dam at the time of inspection.

c. Appurtenant Structures. The spillway weir, outlet culverts and culvert headwalls are in excellent condition, Photos No. 8, 9 and 10. The roadway crossing over the spillway has railing protection on the pond side and concrete guard posts on the downstream side, all of which are in good to excellent condition.

The observed portion of the existing outlet is of cut stone construction. An opening on the top of the intake has a loose steel grating held down by a large rock. The gate house, also of cut stone masonry construction, is in satisfactory condition, Photos No. 12 and 13. The steel entrance door shows signs of rusting and has been recently reinforced with steel angles. The gate valve is manually operated and was reported to be operational. The conduit and gate valve are under full hydraulic head, which is not a recommended arrangement.

d. Reservoir Area. The area around Stodge Meadow Pond is generally wooded rolling hills. There appears to be little probability that landslides into the reservoir would cause waves which would overtop the dam. Approximately 100 cottages and homes are scattered along the shoreline. No conditions which might result in a sudden increase in sediment load into the pond were noted.

e. Downstream Channel. Discharges from the spillway and the low level outlet are carried to the Marble Pond through two separate 500-ft. long channels. The spillway outlet channel, which is 14 ft. wide, is protected with hand-placed and grouted granite blocks to a length of about 30 ft. The existing large boulders and relatively heavy vegetation on the banks of both the channels provide protection against the scouring during normal flows. The condition of the downstream channel is shown in Photos No. 10 and 11.

3.2 Evaluation

Based on the visual examination conducted on 15 November 1978, the Stodge Meadow Pond Dam project is considered to be in good condition. However, the remedial measures outlined in Section 7.3 should be implemented to correct the noted deficiencies in the dam embankment and at the outlet structure entrance.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 Procedures

There are general, but not formal procedures to provide routine maintenance and operation of the dam.

4.2 Maintenance of Dam

There are no established procedures or manuals to assure periodic inspection and maintenance of the dam.

4.3 Maintenance of Operating Facilities

There is no formal plan to maintain the stoplogs at the spillway control weir and the gate valve at the outlet conduit. A couple of stoplogs at the spillway are removed each fall and replaced each spring. The manually opened gate valve for the 24-in. outlet is opened each year.

4.4 Description of any Warning System in Effect

There is no warning system or emergency preparedness plan in effect for this structure.

4.5 Evaluation

The owner should prepare an operations and maintenance manual for the dam. The manual should delineate the routine operational procedures and maintenance work to be done on the dam to ensure satisfactory operation and minimize deterioration of the facility.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. General. Stodge Meadow Pond is an impoundment which is used strictly for recreational purposes. The dam is a curved earth embankment type with a concrete overflow spillway. It is reported that the spillage from the reservoir is usually at a low quantity. The dam crest slopes longitudinally towards the spillway to its lowest point, El. 1134 from both abutments at El. 1135.

b. Design Data. Construction of the existing concrete overflow spillway was completed in 1977. The design parameters were as follows:

Watershed Area:	500 Acres
Pond Area:	110 Acres
Rainfall:	3 in./hr (100-yr storm)
Rainfall Concentration:	5 in. in 20 minutes
Estimated Maximum Discharge:	406 cfs

No computation was shown for design of overflow weir section of the spillway. A 2-ft. wide by 3.5-ft. deep section of the spillway is controlled by stoplogs.

Design parameters of the two conduits which are located underneath the earth embankment at downstream of the spillway are shown below:

d = 54-in. n = 0.015 s = 0.0375 q = 310 cfs; for two conduits q = 620 cfs

c. Experience Data. In several inspection reports of the past, it was mentioned that capacity of the old spillway was not adequate; the dam was overtopped by the 1936 and (probably) the 1938 storms. The new concrete spillway and the culverts were constructed in 1977.

d. Visual Observations. Water level in the pond was about 1 ft. below the spillway crest elevation. No evidence of any damage to the new spillway and the related facilities or the old outlet works was visible at the time of the inspection. The discharge channel leading from the spillway toward Marble Pond was overgrown with relatively heavy vegetation which would effect the hydraulic performance during periods of high discharge.

e. Test Flood Analysis. Based upon discussions with Corps of Engineers personnel, the recommended test flood for the size "small" and the hazard potential "low" is about 1/4 PMF (Probable Maximum Flood). The PMF was determined using Corps of Engineers guidelines for "Estimating Maximum Probable Discharges" in Phase I Dam Safety Investigations. The watershed terrain was determined to be midway between "rolling" and "mountainous" and inflow rate of 2600 cfs per square mile was extrapolated for the drainage area of 0.93 square miles. This resulted in a test flood inflow of 605 cfs. Surcharge-Storage routing was performed through Stodge Meadow Pond with utilization of the related stage-discharge and area-volume curves which are shown in Appendix D. The resulting test flood outflow of 240 cfs with the flashboards removed would cause the water surface elevation in the pond to rise to about 1133.6 or about 0.4 ft. below top of the dam.

f. Dam Failure Analysis. Based on Corps of Engineers Guidelines for Estimating Dam Failure Hydrographs and assuming that a failure would have occurred along the mid-height of 180 ft. long section of the dam, the peak failure outflow is estimated to be 4760 cfs. The first downstream reach for flood routing was selected to be between the Stodge Meadow Pond and the Marble Road which includes the Marble Pond. Assuming the existing outlet facilities of the Marble Pond and the Marble Road would remain intact, the flood stage levels at upstream of the road and at the Marble Pond would be 1115.7 and 1122.1, respectively. The road surface would be overtopped by about 2.2 ft. of water. At these stages no dwellings are expected to be flooded; however, an abandoned mill house and a portion of the Marble Road may be washed out.

The peak failure outflow from the first reach (Marble Pond) was determined to be 3940 cfs. The channel between the Marble Road and the Old Ashby Road was studied as the second reach. The dam failure discharge would be further reduced to about 3700 cfs at this reach before arriving to Old Ashby Road which would be overtopped by about 2 ft. of water during the flood.

In conclusion, the potential hazard in the event of a dam failure is considered low as no loss of life is expected and property damages would be confined to secondary roads and an abandoned mill building.

SECTION 6 - STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations. There was no visual evidence of settlement, lateral movement or other signs of structural instability in the earth embankment or the downstream stone retaining wall. A soft wet area shown on page C-1, discussed in Section 3.1.b. and noted in Appendix A is a possible zone of seepage. No flowing water was observed; however, the presence of leaves and brush precluded close examination of a large area of the ground surface.

There was no observed visual evidence of movement or distress in the spillway or outlet works.

b. Design and Construction Data. Design and construction data for the original construction of the dam are unavailable. Therefore, there is no data with which to assess the embankment. A survey plan of the dam dated March 12, 1974, as well as plans for the spillway reconstruction dated 1976 are available. Review of the construction drawings for the new spillway indicates this structure is currently stable.

c. Operating Records. No operating records are known to exist for the embankment, spillway or outlet works.

d. Post-Construction Changes. The present spillway was constructed in 1977 and replaced a former spillway. Due to the absence of the original plans, other post-construction changes could not be determined.

e. Seismic Stability. Stodge Meadow Pond is located in a Seismic Zone 2 and in accordance with Recommended Phase I Guidelines does not warrant seismic analysis.

SECTION 7 - ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. The visual examination of Stodge Meadow Pond dam revealed that the structure was in good condition. Although there were no signs of structural failure or other conditions which would warrant urgent remedial action, several deficiencies were noted.

Based on the results of computations included in Appendix D and described in Section 5, the spillway is capable of passing the test flood, which for this structure is 1/4 PMF, without overtopping the dam. With the water level at the top of the dam, the spillway has a capacity of 325 cfs with all the stoplogs removed. The test flood outflow of 240 cfs (258 csm) could then be passed with a freeboard of 0.4 ft. and storage of 210 acre-ft. remaining.

b. Adequacy of Information. This evaluation of the dam is based primarily on visual inspection, past performance and engineering judgement. There was a lack of engineering data available for consideration in the assessment, but the information subsequently obtained was adequate for the purposes of a Phase I Investigation.

c. Urgency. The remedial measures outlined in Section 7.3 should be undertaken by the Owner and completed within 2 years after receipt of this report.

d. Need for Additional Investigation. No additional investigation is considered necessary at this time.

7.2 Recommendations

Not applicable.

7.3 Remedial Measures

Although the dam is generally in good condition, it is considered important that the following items be accomplished.

a. Operation and Maintenance Procedures. The following remedial work should be undertaken by the Owner:

1. Clear away leaves and vegetation in the vicinity of the apparent seepage area on the downstream slope and make periodic visual observations,

noting carefully the extent of the wet area, evidence of active seepage and related information for correlation with rainfall, snowmelt, pond level, etc. The object of this activity will be to determine whether the wet area is related to pond level (and thus seepage) or merely surface manifestations of seasonal effects of rainfall, etc.

2. Repair the eroded areas in upstream slope and extend the slope protection to the top of the embankment.

3. Cut and remove trees and brush on the crest and slopes of the embankment. Stumps may be cut flush with the ground and left in place. For the future, the downstream slope should be mowed at least once a year to allow for visual examination of the embankment.

4. Supply a more conventional hold down device for the grating at the outlet conduit intake entrance so that it could be removed quickly in the event of a problem.

The owner should prepare an operations and maintenance manual for the dam. The manual should include provisions for biennial technical inspection of the dam and for surveillance of the dam during periods of heavy precipitation and high reservoir water levels. The procedures should delineate the routine operational procedures and maintenance work to be done on the dam to ensure satisfactory operation and to minimize deterioration of the facility.

7.4 Alternatives

Not applicable.

APPENDIX A - INSPECTION CHECK LIST

VISUAL INSPECTION PARTY ORGANIZATION

NATIONAL DAM INSPECTION PROGRAM

Dam: Stodge Meadow Pond

Date: 15 November 1978

Time: 1115-1405

Weather: Clear, cool (40's F)

Water Surface Elevation Upstream: El. 1130.8 (15 in. below top of concrete spillway weir)

Stream Flow: None

Inspection Party:

Peter L. LeCount	- Soils/Geology
Richard P. Stulgis Haley & Aldrich, Inc.	
A. Ulvi Gulbey	- Hydraulic/Hydrologic
Charles E. Fuller	
Joseph E. Downing	
Robert P. Howard Camp, Dresser & McKee, Inc.	- Structural/Mechanical

Present During Inspection:

Mr. Raymond L. Leslie, Stodge Meadow Association, Inc.

VISUAL INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM

DAM: Stodge Meadow Pond DATE: 15 Nov. 78

AREA EVALUATED	CONDITION
DAM EMBANKMENT	
Crest Elevation	Assumed to be lowest point on roadway, approximately El. 1134
Current Pool Elevation	15 in. below top of spillway, approximately El. 1130.8
Maximum Impoundment to Date	Unknown
Surface Cracks	None observed
Pavement Condition	Gravel surfaced roadway
Movement or Settlement of Crest	None evident
Lateral Movement	None evident
Vertical Alignment	Satisfactory
Horizontal Alignment	Curved
Condition at Abutment and at Concrete Structures	No distinct abutment contact; riprap adjacent to spillway structure
Indications of Movement of Structural Items on Slopes	None
Trespassing on Slopes	None evident, chain link fence adjacent to spillway weir and outlet works
Animal Burrows in Embankment	None observed
Vegetation on Embankment	Brush and trees (6 to 12 in. dia.) upstream, scattered trees up to 18-in. dia. downstream
Sloughing or Erosion of Slopes or Abutments	Some erosion of top of bank by wave action upstream, vertical stone face wall in good condition downstream
Rock Slope Protection - Riprap Failures	Stones locally dislodged from upstream wall on right side, cobble and boulder protection on left side locally thin
Unusual Movement or Cracking at or near Toes	None observed
Unusual Embankment or Downstream Seepage	Ponded water at surface in area of toe (along area of maximum dam height); irregular earth slope below stone wall - soft organic soils at surface extending several feet up slope (Wet). Possible seepage, although flowing water was not observed

VISUAL INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM

DAM: Stodge Meadow Pond DATE: 15 Nov. 78

AREA EVALUATED	CONDITION
Piping or Boils	None observed
Foundation Drainage Features	None
Toe Drains	None
Instrumentation Systems	None
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	
General Condition	Good
Loose Rock Overhanging Channel	None observed
Trees Overhanging Channel	None observed
Floor of Approach Channel	Submerged. Not visible
b. Weir and Training Walls	
General Condition of Concrete	Excellent, appears to be of recent construction
Rust or Staining	None observed
Spalling	None observed
Any Visible Reinforcing	None observed
Any Seepage or Efflorescence	None observed
Drain Holes	None observed
c. Discharge Channel	
General Condition	Twin corrugated steel pipe culvert with concrete headwalls in excellent condition. Railing on upstream headwall and three concrete posts near downstream headwall are in good to excellent condition. Discharge channel for a short distance beyond culvert has placed stone slabs in good condition.

VISUAL INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM

DAM: Stodge Meadow Pond DATE: 15 Nov. 78

AREA EVALUATED	CONDITION
Loose Rock Overhanging Channel	None observed within stone-slabbed area of channel
Trees Overhanging Channel	None observed within stone-slabbed area of channel
Floor of Channel	Floor within stone-slabbed area of channel is in good condition
OUTLET WORKS - INTAKE CHANNEL AND OUTLET CONDUIT INTAKE	
a. Approach Channel	Not applicable. Intake drains directly from pond
b. Intake Structure	
Condition of Structure	Major portion of intake is submerged. Visible portion of intake is a dry laid cut stone. Opening on the top of the intake has a loose grating held down by a large rock. Observed portion is satisfactory
Stop Logs and Slots	None
OUTLET WORKS - GATE HOUSE	
a. Concrete and Structural	
General Condition	Dry-laid cut stone masonry structure in good condition. Door shows signs of rusting and has been recently reinforced with steel angles
Condition of Joints	Not applicable
Spalling	Not applicable
Visible Reinforcing	Not applicable
Rusting or Staining of Concrete	Not applicable
Any Seepage or Efflorescence	None observed
Joint Alignment	Good
Unusual Seepage or Leaks in Gate Chamber	None observed

VISUAL INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM

DAM: Stodge Meadow Pond DATE: 15 Nov. 78

AREA EVALUATED	CONDITION
Cracks	None observed
Rusting or Corrosion of Steel	Steel doore shows signs of rusting
b. Mechanical	Manually operated gate valve. Reported by the owner as being operational. Owner was reluctant to open as the valve is hard to seat. Owner reportedly opens gate once a year

FILE NO. 4160

APPENDIX B - ENGINEERING DATA

LIST OF AVAILABLE DATA
STODGE MEADOW POND DAM

Document	Contents	Location
County inspection reports and related correspondence	21 reports throughout the period from 9 October 1924 to 20 November 1970	Office of the County Engineer, Room 101, Court House, 2 Main Street, Worcester, MA 01608
State inspection report	Report dated 16 December 1971	Mass. Dept. of Environmental Quality Engineering, Division of Waterways, 100 Nashua Street, Boston, MA 02114
"Site Plan of Dam Area", Michael S. Szoc, Registered Land Surveyor, 12 March 1974	26 in. by 35.5 in., 20 scale topographic plan	Michael S. Szoc, Worcester County Bank Building, 32 Pleasant Street, Gardner, MA 01440
"Supplementary Plan of Spillways", Michael S. Szoc, Registered Land Surveyor, 12 March 1974	15 in. by 11.5 in., 8 scale drawing showing side and top view of old service spillway and side view of drop inlet spillway	Michael S. Szoc, Worcester County Bank Building, 32 Pleasant Street, Gardner, MA 01440
"Spillway Construction", George W. Lanides, P.E., October 1976	18 in. by 27 in. drawing showing design criteria, specifications and details for the 1977 construction of the conduit spillway	R.E. Smith, P.E., 265 Mt. Vernon Street, Fitchburg, MA 01420 and Appendix B-

3-14-11-38

INSPECTION REPORT & DATA FOR DAMS

Dam No. 3-14-11-38
Town: Ashburnham
Stream: Whitemans Brook
Pond: Stodge Meadow Pond
Date: 12-16-71
By: Eaton & Canu

Owner: Stodge Meadow Assn. Inc.
His Address: Raymond Leslie, Stodge Meadow, Ashburnham
Function of Dam: Recreation.

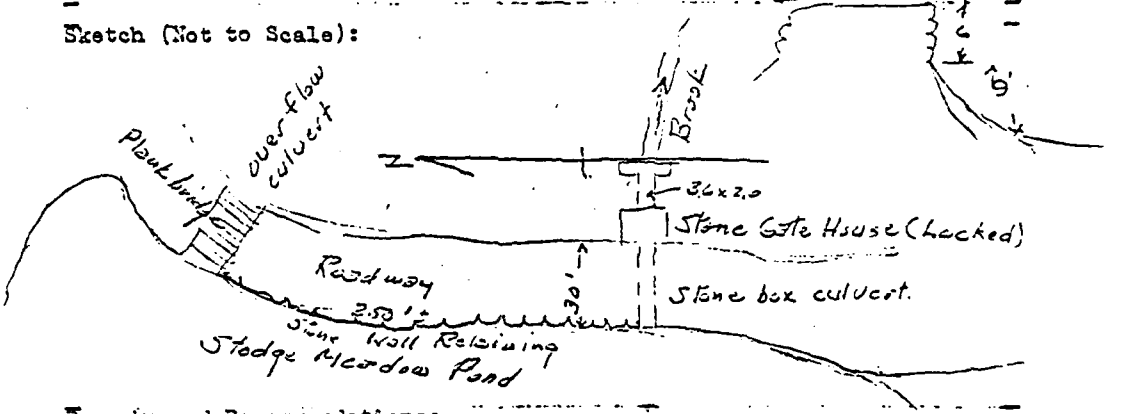
Location & Access: On Road that runs along Eastern Shore of Pond at Northern End
USGS Quad. Ashburnham Lat. 42°40'12" Long. 71°52'55"
Drain.Ar.: 1.1 Sq.Mi.; Ponds: 110 ac.; Res.Sdam:
Character of D.A.:

CONDITION RATING
Structural: Exc
Hydraulic: 3.6 x 2.0
General: Good
PRIORITY:

Estimated
Discharge
Capacity:

General Description of Dam and Discharge Control:
Stone-walled earth filled dam

Sketch (Not to Scale):

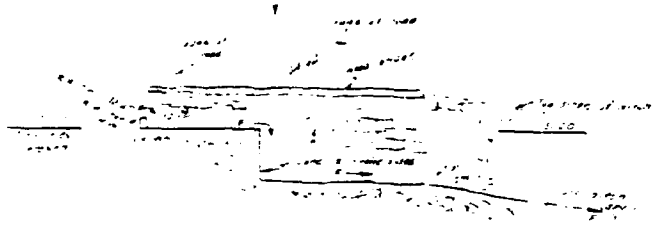


Remarks and Recommendations:
Trees up to 8" growing on sides of road across dam. Should be cut.

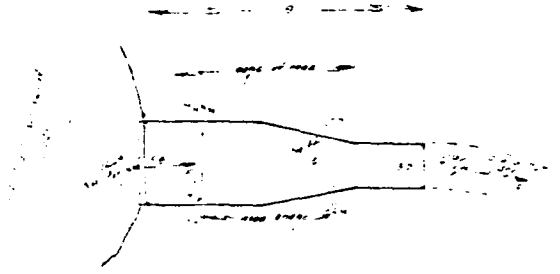
Date 12/16/71 By EATON+CANU Comment

Dam No. 3-14-11-38

OLD SPILLWAY & WOOD BRIDGE

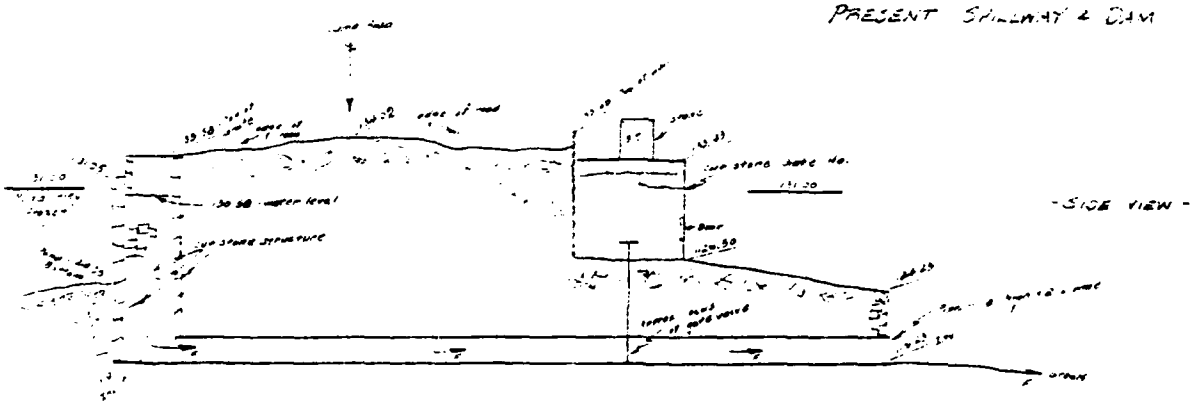


- SIDE VIEW -



- TOP VIEW -

PRESENT SPILLWAY & DAM



- SIDE VIEW -

SUPPLEMENTARY PLAN OF SPILLWAYS

for

STODGE MEADOW ASSOCIATION, INC.

ASHBURNHAM, MASS.

Hor. 1 inch = 8 ft.

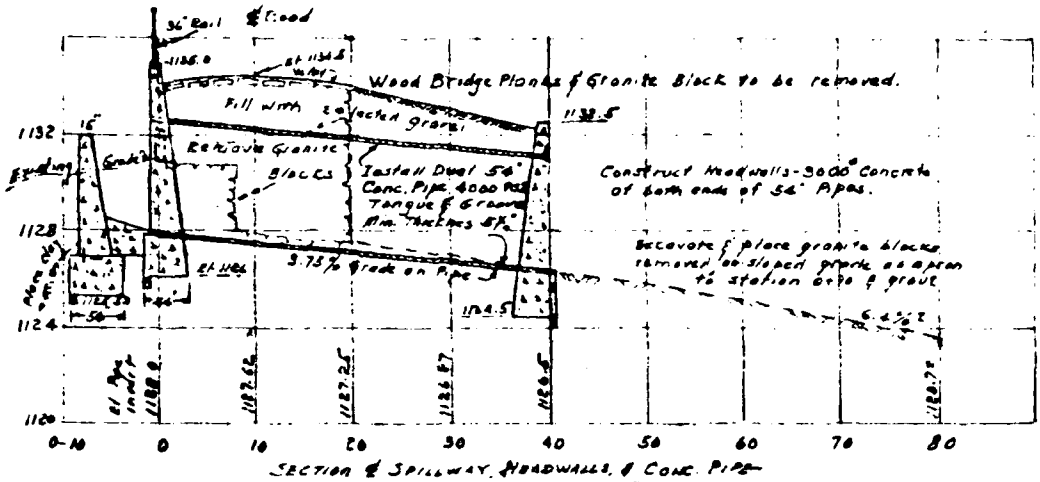
Scales:

Vert. 1 inch = 8 ft.

March 18, 1974

MICHAEL J. SLOC

A - Surveyor

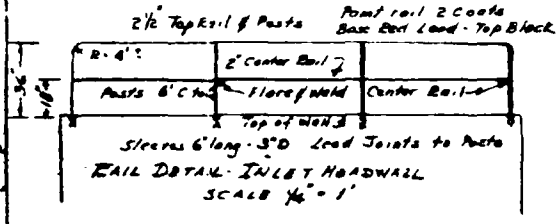


SECTION @ SPILLWAY, HEADWALLS, & CONC. PIPE
SCALES: HOR. 1" = 10' VERT 1" = 4'

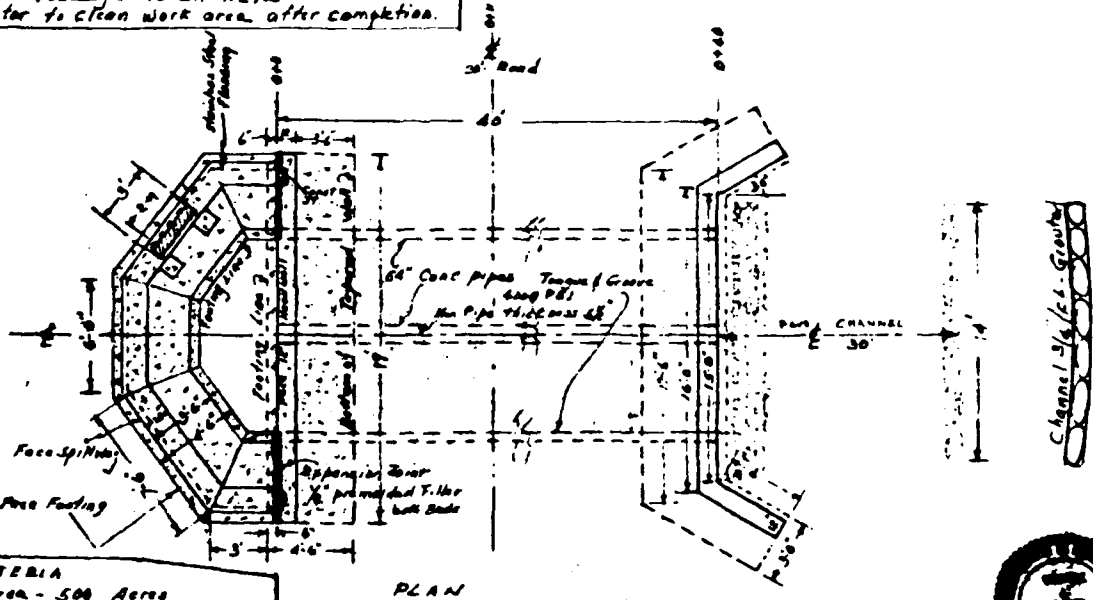
Existing Plank Spillway - 0+10 @ Elev. 1132.0
Upstream face of Conc Spillway - 0+00 Top El = 1132.0
All Concrete foundations on Compacted Gravel.
Spillway to be of 4000# concrete.

SPECIFICATIONS

1- All Construction shall be according to Plan
2- Changes shall not be made without Consent by Engineer
3- Changes not affecting design may be approved by Owner
4- Concrete shall be on compacted gravel - 12" thick
5- Spillway Concrete 4000# PSI - Retaining Wall 3000# PSI
6- Tongue & Groove Concrete Pipe 4000 PSI - Min Thickness 5½"
7- 4"x 6" Timbers shall be selected Oak, either T&G or Splined, caulked with Oakum. Contractor to determine number timbers required to lower Pond Level 3'-6"
8- Concrete base at Flashboards shall be perfectly level to prevent leakage & warping.
9- Contractor to place clay on upstream Spillway Face to prevent leakage to El = 1127.5
10- Contractor to clean work area after completion.



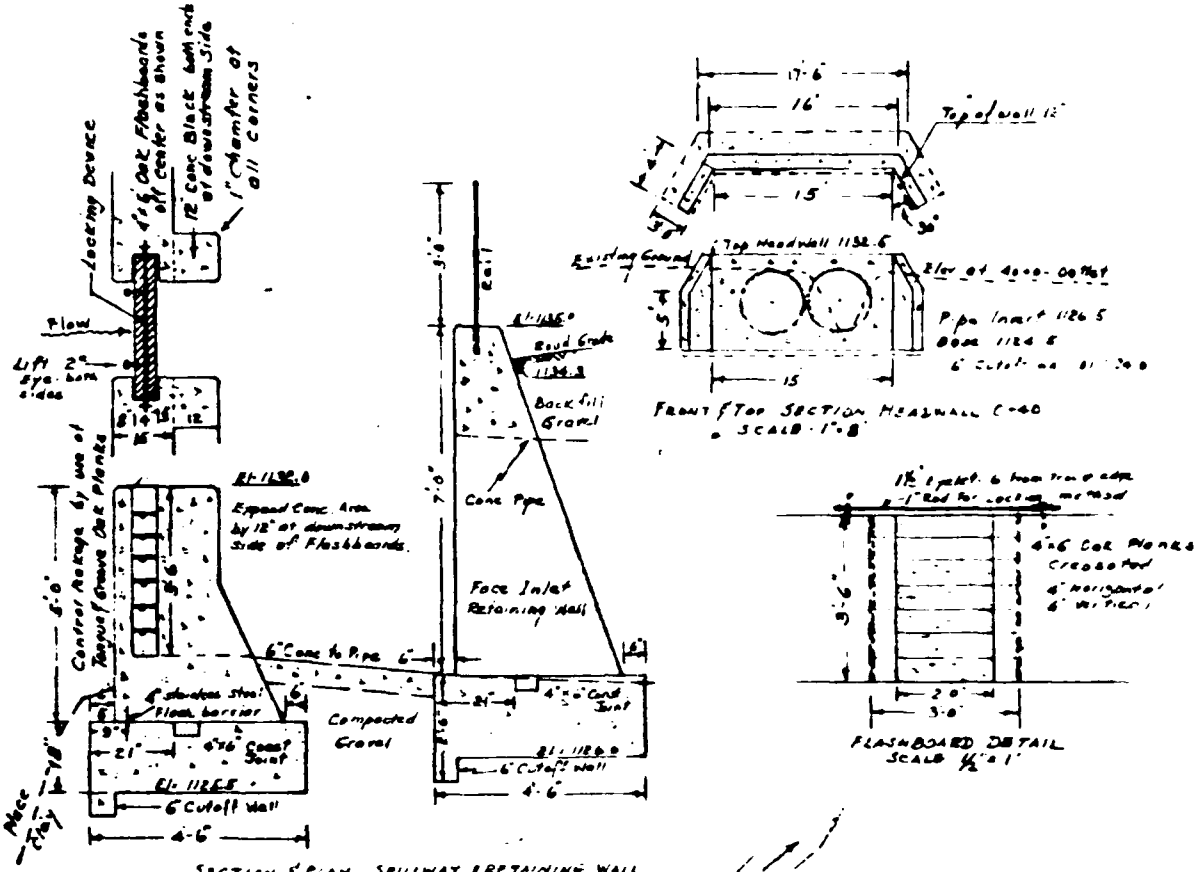
RAIL DETAIL - INLET HEADWALL
SCALE ½" = 1'

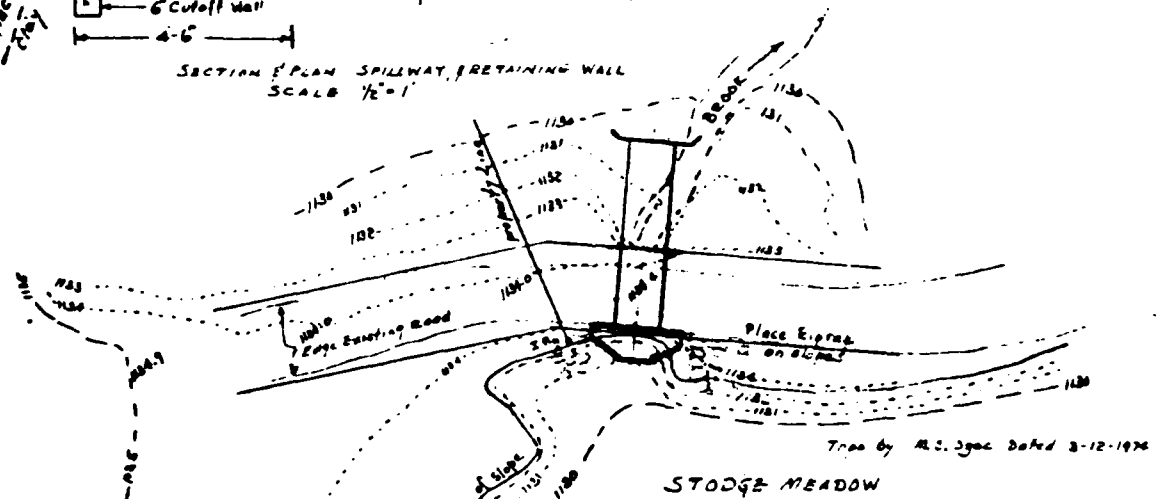


PLAN
SCALE 1" = 5'

DESIGN CRITERIA
Watershed Area - 500 Acres
Pond Area - 110 Acres
Rainfall 100 yr Storm - 3"/hr.
Rainfall Concentration - 20 Min - 5 inches
Rational Formula $Q = ACi\frac{V}{Sec}$
$Q = 500 \times 0.25 \times 5\frac{In}{Hr} = 406$ CFS
54" Pipe, n = 0.015, Slope = 0.325 = 310 CFS
2 - 64" Pipes, $310 \times 2 = 620$ CFS

B.M. = 1132.29 Top of Plank Exist. Spillway





Trace by M.S. Spec Dated 3-12-1976

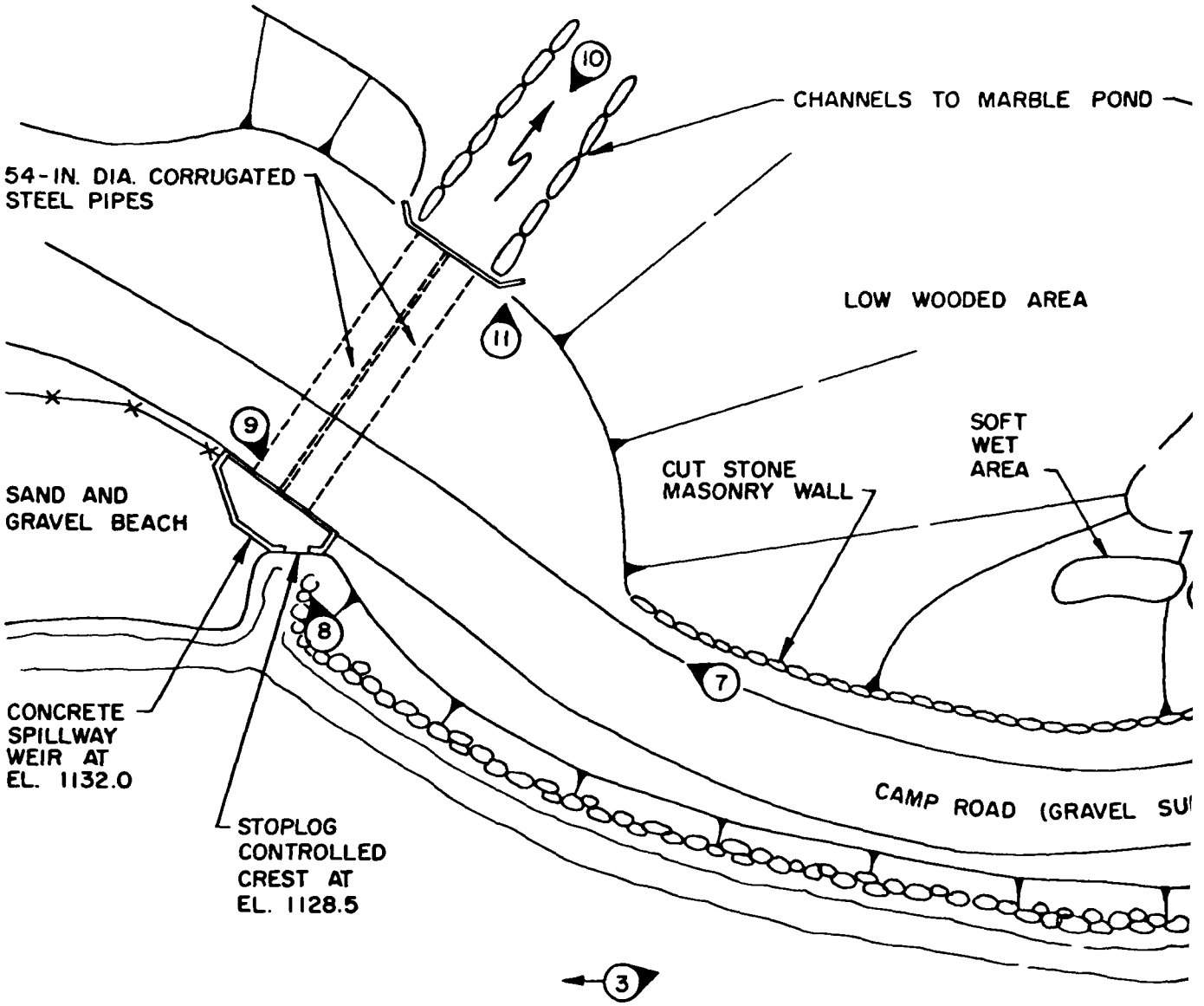
STODGE MEADOW
Long. 71°-58'-56" } Spillway
Lat. 42°-40'-10" }

STODGE MEADOW POND
ASHBURNHAM MASS.
STODGE MEADOW ASSOCIATION INC.
SPILLWAY CONSTRUCTION

GEORGE J. LANIDES REG. ENGINEER
25 WARREN ST. FITCHBURG MASS.

SCALES AS SHOWN OCTOBER 1976

APPENDIX C - PHOTOGRAPHS



NOTE:

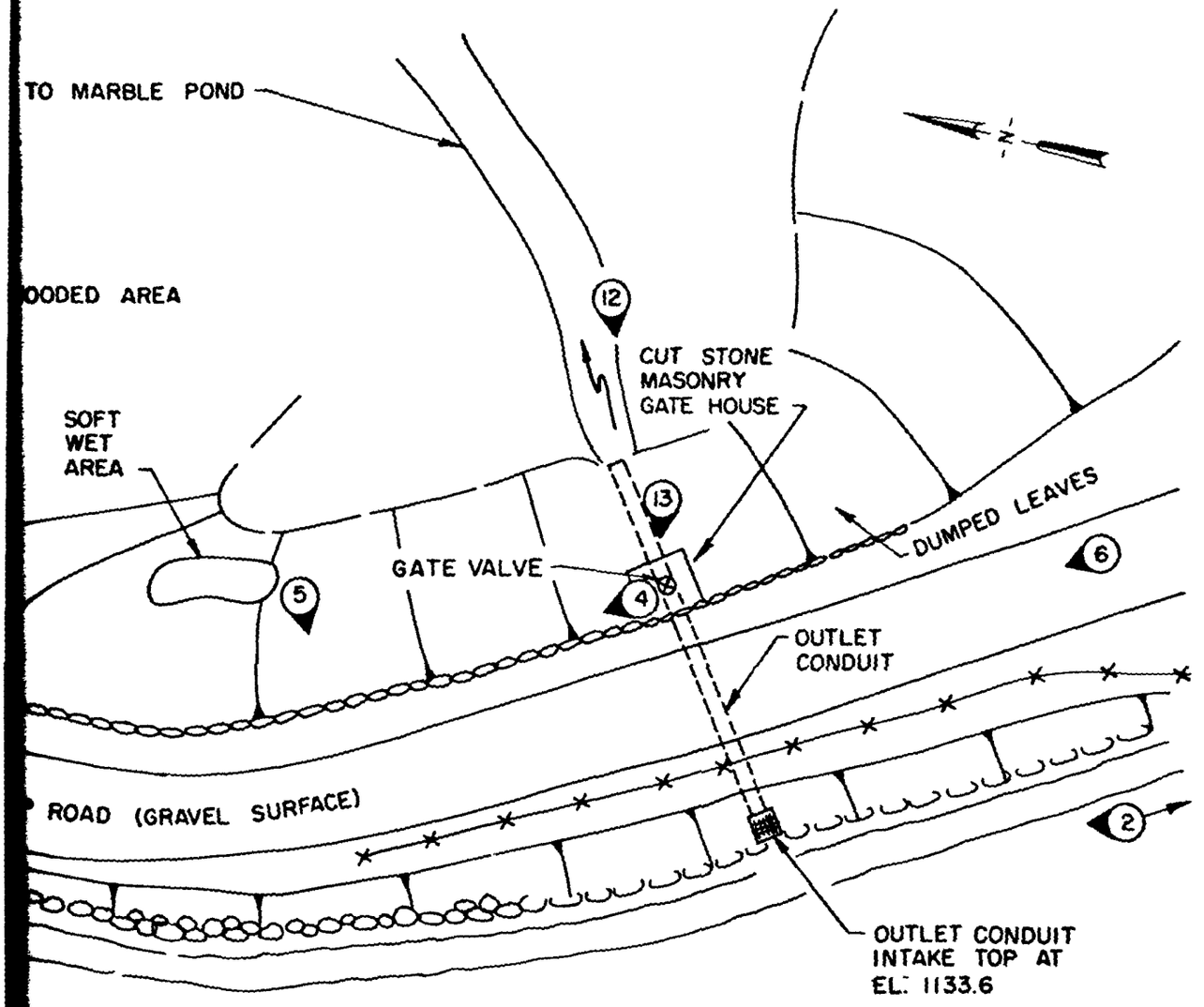
PLAN DEVELOPED FROM DRAWING "SITE PLAN OF DAM AREA" BY MICHAEL S. SZOC, 12 MARCH 1974, AND FIELD OBSERVATIONS ON 15 NOVEMBER 1978.

LEGEND

(5) PHOTO NO. AND DIRECTION OF VIEW.

FILE NO.

HALEY & ALDRICH, INC.
CAMBRIDGE, MASSACHUSETTS



GE MEADOW POND

130.8 ON 15 NOVEMBER 1979)

Stodge Meadow Pond Dam
Ashburnham, MA

SITE PLAN SKETCH

Scale: 1"=20' February 1979

C-1

2. Upstream side near outlet conduit intake

3. Riprap and trees on upstream slope

4. Stone wall and downstream slope near gate house

5. Elevation view of vertical stone wall on downstream side

6. Top of embankment from right abutment

7. Top of embankment near conduit spillway and left abutment

8. Control structure for conduit spillway

9. Spillway weir with stoplogs

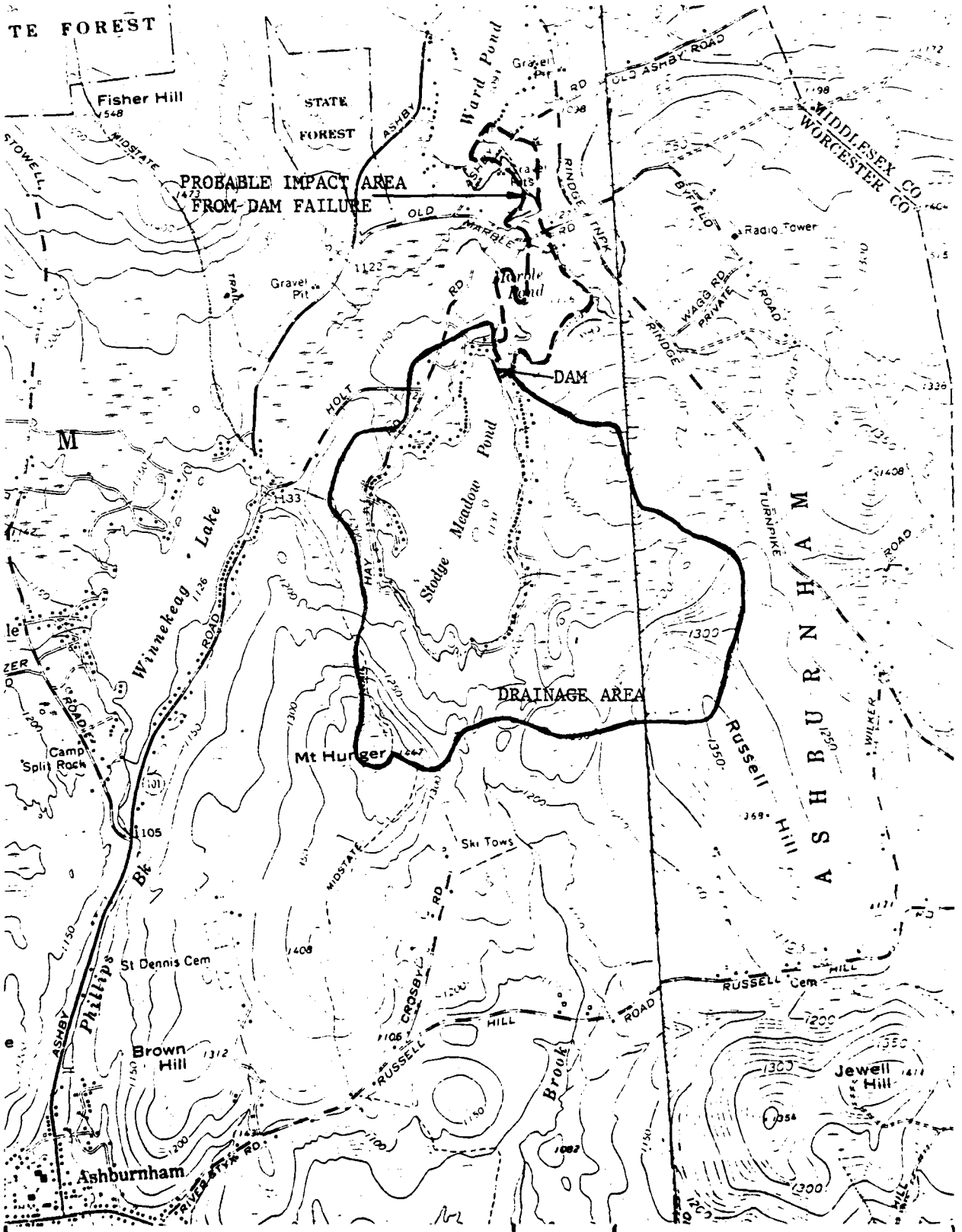
10. Twin 54-in. dia. corrugated steel conduit spillway pipes

11. Downstream channel from conduit spillway

12. Gate house and discharge end of outlet conduit

13. Gate house entrance and gate valve control

APPENDIX D - HYDROLOGIC AND HYDRAULIC COMPUTATIONS



CAMP DRESSER & McKEE Inc.
Consulting Engineers
Boston, Mass.

N

STODGE MEADOW DAM
DRAINAGE AREA AND
FLOOD IMPACT AREA
SCALE: 1:24,000

CAMP DRESSER & McKEE
Environmental Engineers
Boston Mass

CLIENT H & A
PROJECT COE Dam Inspection
DETAIL Stodge Meadow Dam

JOB NO 561-9-ft-1
DATE CHECKED 12/29/78
CHECKED BY HLG

PAGE 1
DATE 12/22/78
COMPUTED BY K. C.

Size Classification

Height: $1134.0 - 1119.25 = 14.75$ say 15-ft < 40 ft.
Storage: 900 acre-ft @ Elev. 1134 < 1000
} SMALL

Hazard Potential Classification

No dwellings are observed within the potential flood plain of the dam: no loss of life is expected.

Economic Loss: minimal with some possible damages to two secondary roads.

Category: LOW

Test Flood Development

Size: Small
Hazard: Low

$Q_T \cong \frac{1}{4}$ PMF

Drainage Area: 597 acres = 0.93 sq mi
Land Topo.: Mid-range between rolling and mountainous terrain.

Peak Flow Rate: 2600 cfs/sqmi (from COE Curves)

$Q_{PMF} = 0.93 \times 2600 = 2420$ cfs.

TEST FLOOD FLOW: $\frac{1}{4} Q_{PMF} = 605$ cfs.

Surcharge - Storage Routing

Test Flood : 605 cfs. (Q_{P_1})

WSE @ the pond : 1134.80 (See Stage-Discharge Curve)

Total Storage Volume : 990 acre-ft (From Area-Volume Curve)
Normal Pond Volume : 690 " "
Surcharge Volume : 300 " "

Surcharge Runoff : $\frac{300}{597} \times 12 = 6''$ (STOR 1)

$Q_{P_2} = 605\left(1 - \frac{6}{5}\right) = (-)$ Indicates a surcharge less than 6-in.

Assume (STOR 2) = 0

STOR Ave $= \frac{6+0}{2} = 3$-in

$Q_{P_2} = 605\left(1 - \frac{3}{5}\right) = 240$ cfs needs back checking:

For $Q = 240$ cfs $\longrightarrow$ WSE = 1133.60

storage : 840 acre-ft

Surcharge : 840 − 690 = 150 ac-ft

Surcharge - Runoff : $\frac{150}{597} \times 12 = 3.02'' \approx 3''$ O.K.

Test flood Outflow : 240 cfs.

Tail Water :

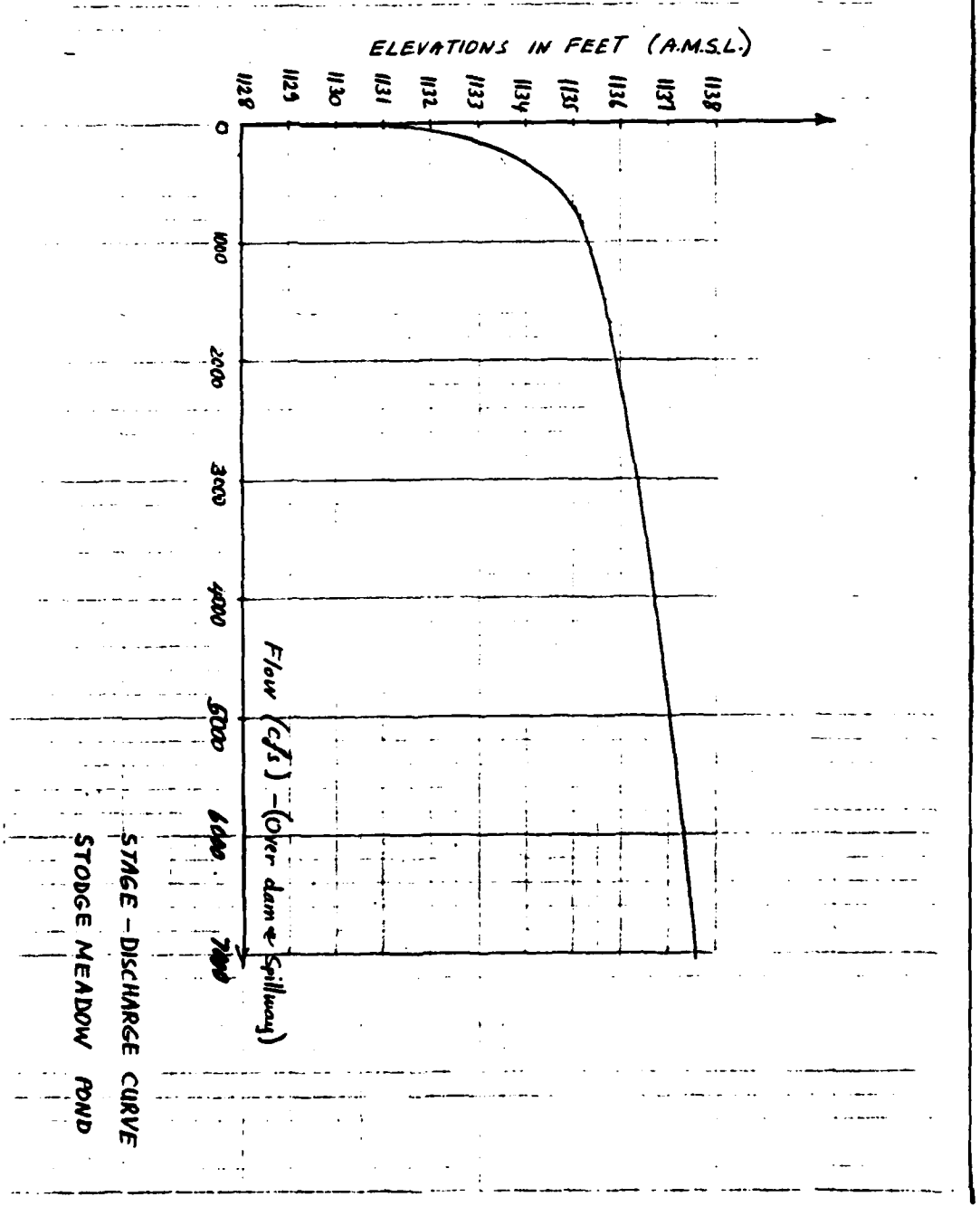
WSE in the Marble Pond for $Q = 240$ cfs $\simeq$ 1118.0
(from stage - discharge curve, assuming no surcharge)
Elevation at the downstream of spillway & Culvert apron : 1126.5
Depth of flow in the outlet channel of the spillway & culverts : $\simeq$ 1128.5 (no surcharge to effect the function of the spillway & Culverts)

CAMP DRESSER & McKEE
Environmental Engineers
Boston, Mass.

CLIENT H & A
PROJECT COE Dam Inspection
DETAIL Stodge Meadow Dam

JOB NO 561-9-RT-1
DATE CHECKED Jan. 2, 79
CHECKED BY AUG

PAGE 3
DATE 12/21/78
COMPUTED BY K. L. Chen



STAGE - DISCHARGE CURVE
STODGE MEADOW POND

CAMP DRESSER & McKEE
Environmental Engineers
Boston, Mass.

CLIENT H&A
PROJECT Dam Inspections
DETAIL Stodge Meadow

JOB NO. 561-9-RT
DATE CHECKED Jan. 2, 79
CHECKED BY AUG

PAGE 4
DATE 12/11/78
COMPUTED BY KS Chan

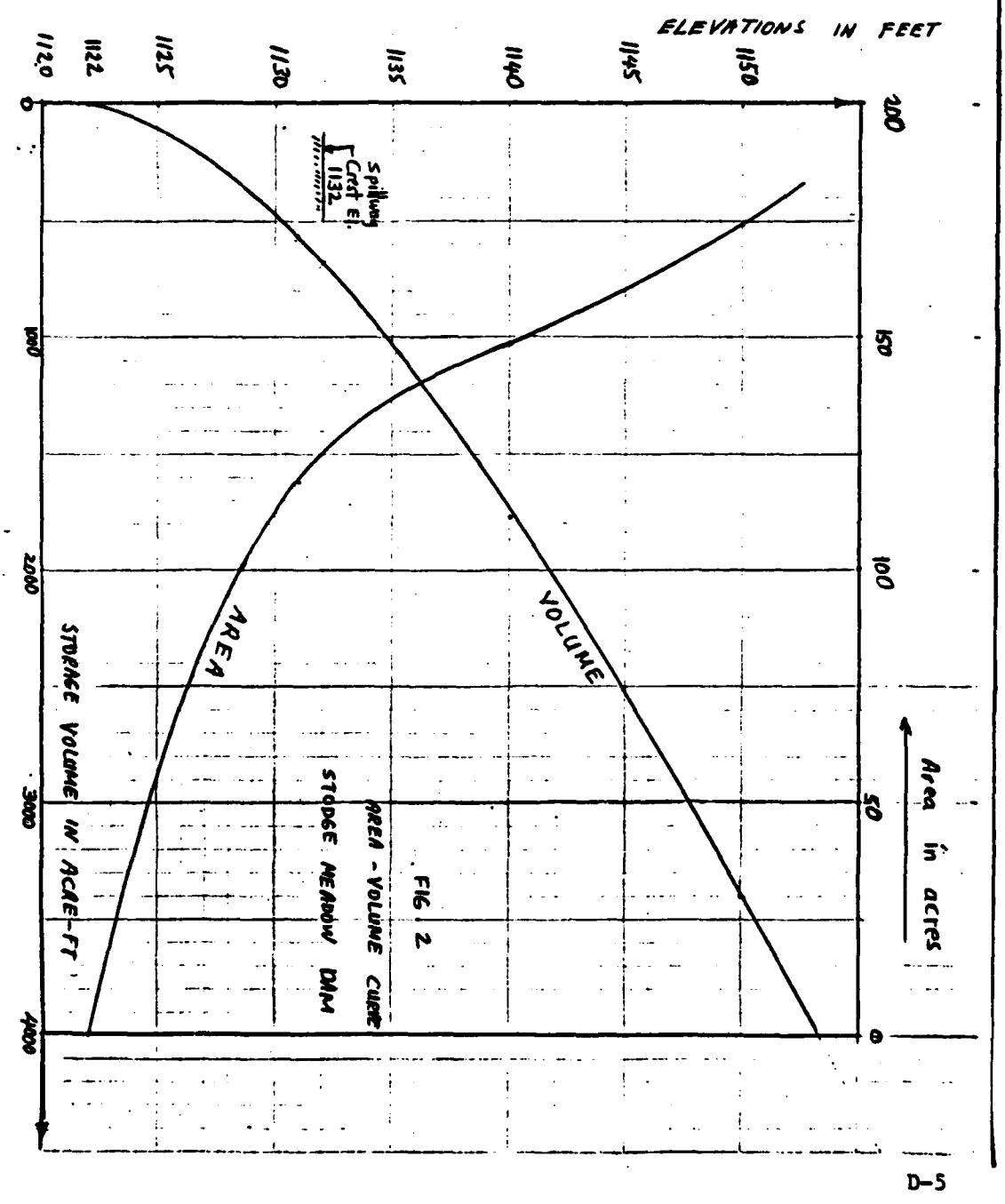


FIG 2
AREA - VOLUME CURVE
STODGE MEADOW DAM

Dam Failure Analysis

$$Q_{p_1} = \frac{8}{27} W_b \sqrt{g}\, Y_o^{3/2}$$

$W_b \cong 0.4 \cdot 125 = 50$ ft (See Section, attached)

Y_o = Total height from stream bed to pool level @ top of the dam. = $1134.0 - 1119.25 = 14.75$

$$Q_{p_1} = \frac{8}{27} 50 \cdot 5.67 \cdot 56.65 = 4{,}760 \text{ cfs}$$

Downstream Channel

$Q_{p_1} = 4{,}760$ cfs ;

WSE @ Stodge Meadow Pond : 1134.° (top of dam)

Storage @ time of failure : 900 acre-ft.

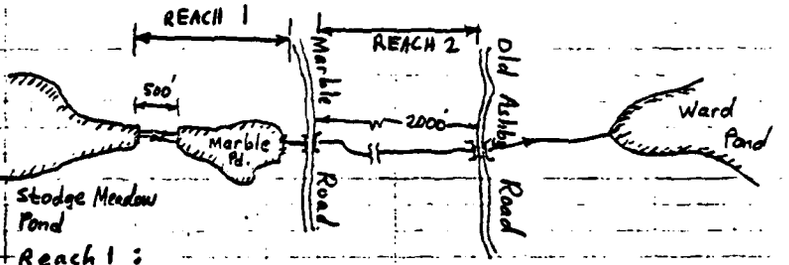


Fig. 7

Reach 1 :

HGL El. @ Marble Road (see Stage-discharge Curve) : 1116.10

This indicates that the Marble Pond outlets (spillway, emergency spillway and the dyke) will not be hydraulicly submerged.

WSE @ Marble pond @ Q failure: 1122.60 (from stage-discharge curve for Marble Pond) - Fig. 6

Storage Volume 1 in Marble Pond : 165 acre-ft $< \frac{900}{2}$

CAMP DRESSER & McKEE
Environmental Engineers
Boston, Mass.

CLIENT H & A
PROJECT COE Dam Inspection
DETAIL Stodye Meadow Road Dam

JOB NO. 561-9-RT
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PAGE 6
DATE 12/13/78
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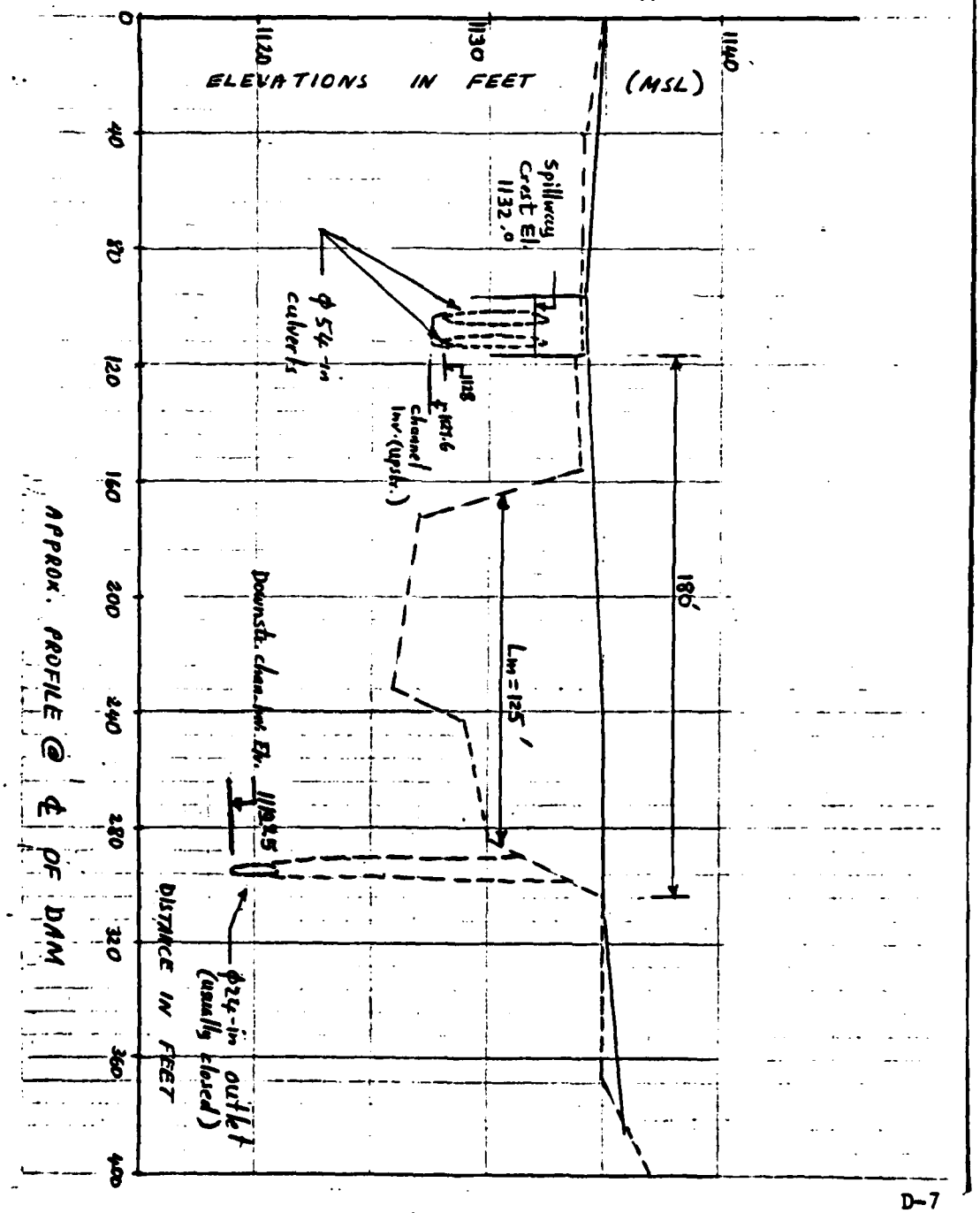

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DETAIL Stodge Meadow Dam

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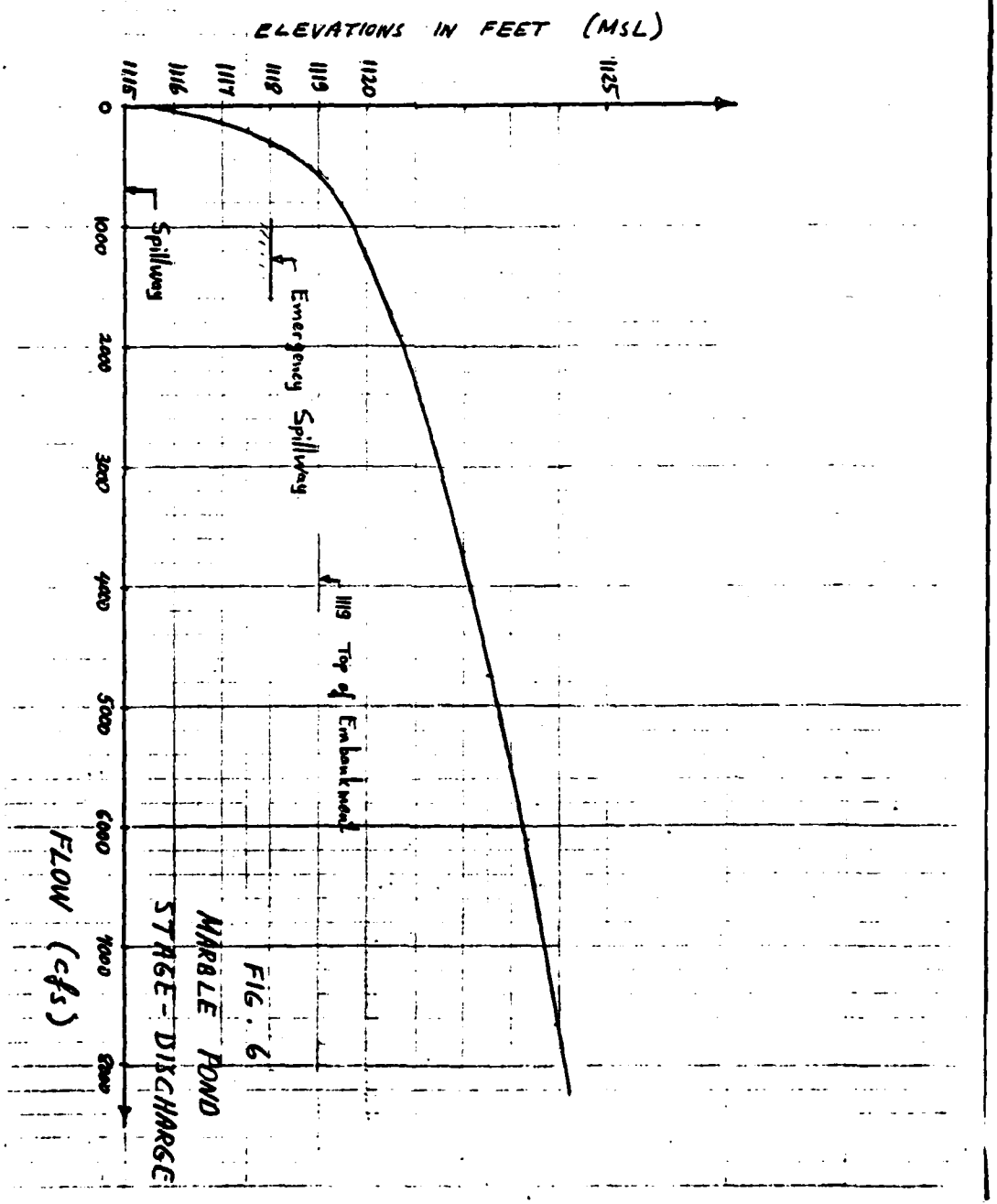

FIG. 6

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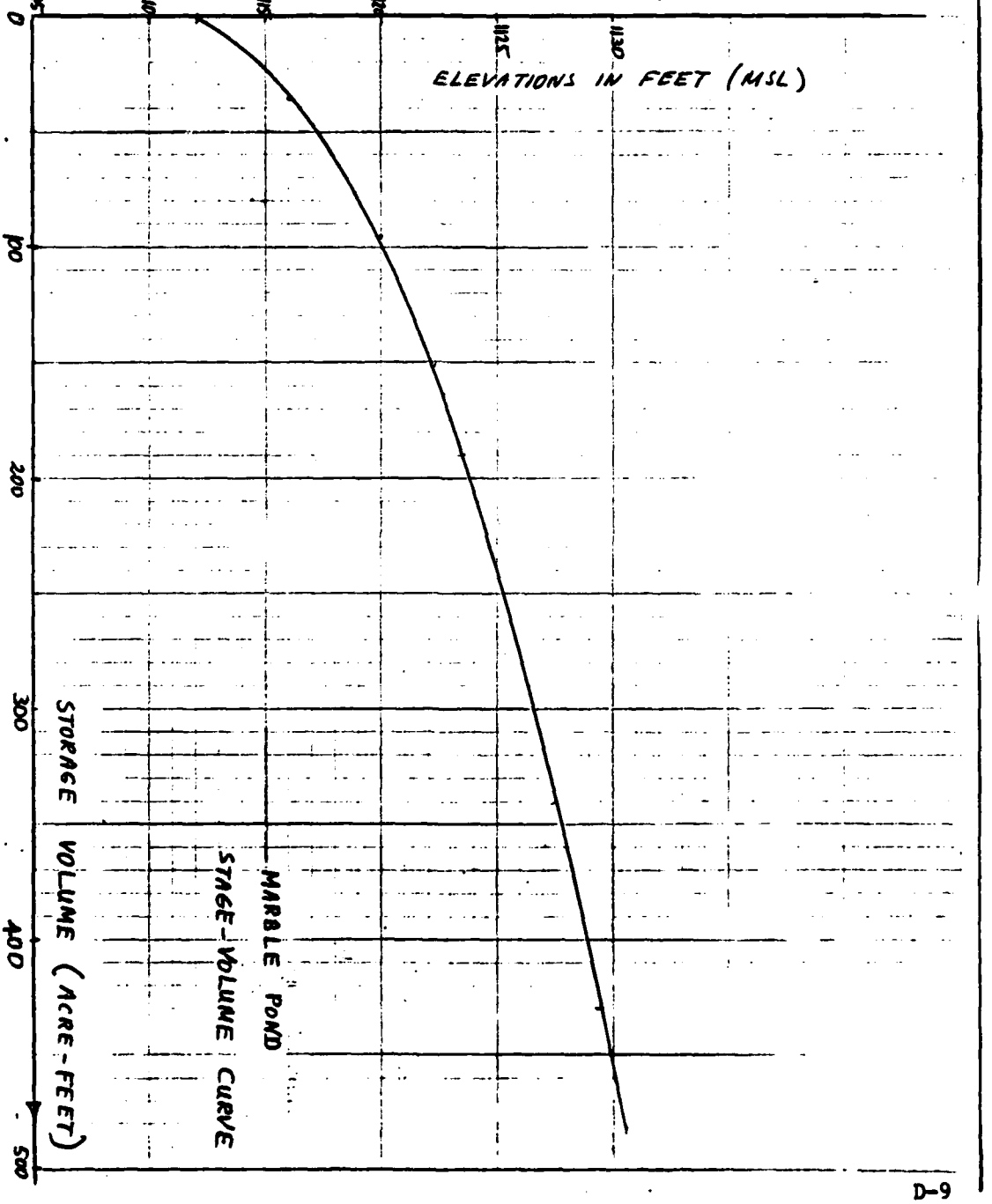

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DETAIL Stodge Meadow Dam

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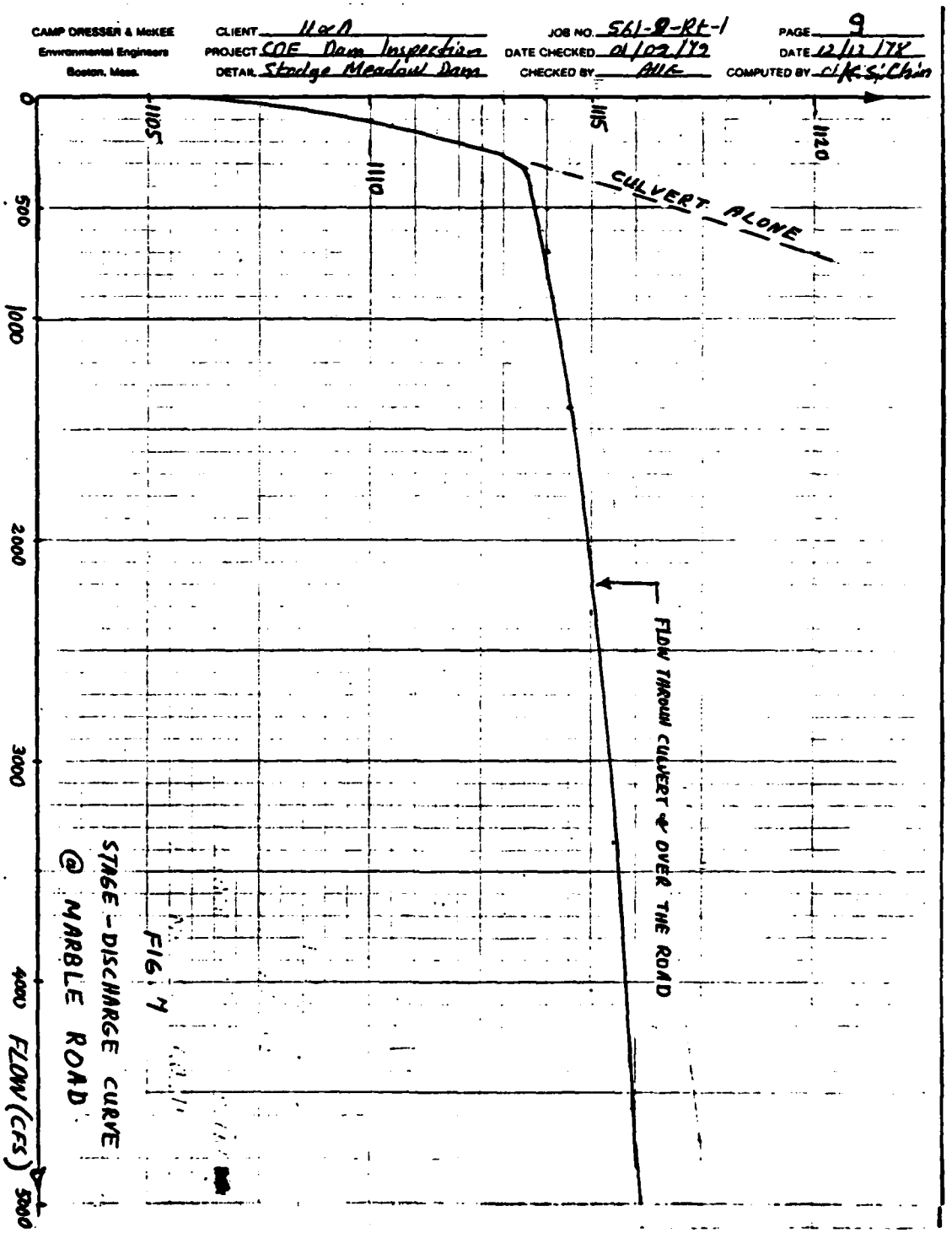


FIG. 7

STAGE - DISCHARGE CURVE
@ MARBLE ROAD

Q_{p_2} (trial) $= 4760\left(1 - \frac{165}{900}\right) = 3890$ cfs.

WSE @ Marble Pond : 1122.10

Storage Volume 2 : 150 acre-ft

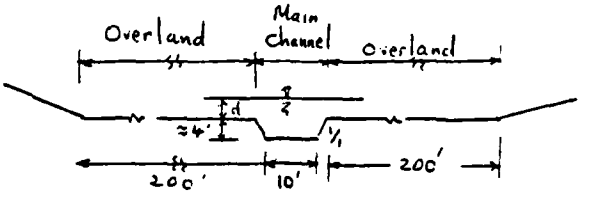
Average Storage Volume : 155 ac-ft

$Q_{p_2} = 4760\left(1 - \frac{155}{900}\right) = 3940$ cfs (outflow)

HGL El. @ Marble Rd. = 1115.70 (Fig 7)

The road would be overtopped by about 2-ft of water.

Reach 2



$Q_{p_2} = 3940$ cfs.

$A_1 = 50 + 18d$ (Main channel)

Try $d = 1.6$ ft

$A_1 = 84.8$ ft^2 $\quad R_1 = \frac{84.8}{21.5} = 3.94 \quad R_1^{2/3} \simeq 2.5$

$A_1 R_1^{2/3} = 212 \quad S = 0.006$ (from USGS) $\rightarrow \sqrt{S} = 0.078$

Q_1 (main channel) $= \frac{1.49}{0.035} 84.8 \cdot 2.5 \cdot 0.078 = 705$ cfs

Q_2 (overland) : $A_2 = 1.6 \times 400 = 640 \quad W = 403$

$R \simeq 1.5 \quad R^{2/3} = 1.31 \quad n = 0.035$

$Q_2 = 2785$ cfs $\quad \Sigma Q \simeq 3{,}500$ cfs.

Try $d = 1.7$ ft. $\rightarrow A_1 = 86.6$ sf $\quad R_1 = 4.03$

$R^{2/3} = 2.53 \qquad Q_1 = 728$ cfs.

$$Q_2 = \frac{1.49}{0.035} \times 680 \times 1.42 \times 0.078 = 3217 \text{ cfs}$$

$\Sigma Q = 3945$ cfs ≈ 3940 O.K.

Reach Storage: $2000(56 + 1.7 \times 420)\frac{1}{43560} = 35$ ac-ft.

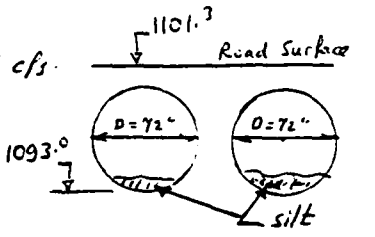
$$Q_{p_3} = 3940\left(1 - \frac{35}{900-165}\right) = 3,700 \text{ cfs}.$$

Old Ashby Road & Culverts

Full capacity of culverts:

$$2q = 2\,\frac{1.49}{0.035}\,28.3 \times 1.31 \cdot 0.078 = 245 \text{ cfs}$$

The flood water level was about 1-ft above the road surface during Aug. 1965 storm; estimate Q:



(Note elevs. estimated from USGS)

a) Culverts:

$q = c \cdot a \cdot \sqrt{2gh} = 342$ cfs

$c = 0.6$

$2q = 684$ cfs.

b) flow over the road: $L \cong 400$ ft.

$Q = 2.6 \times 400 \times 1^{3/2} = 1040$ cfs

$\Sigma Q = 1724$ cfs. < 3700 cfs Q failure.

Try $h = 2$ -ft. 9 culverts = 760 cfs
9 over road = 2940 "
Total = 3700 "

Conclusion: The Old Ashby road would be overtopped by about 2.0-ft of water.

APPENDIX E - INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

INVENTORY OF DAMS IN THE UNITED STATES